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ABSTRACT

The "Standards" of the National Council of Teachers of Mathematics (NCTM) were established as a broad framework to guide reform in school mathematics, not as a specific curriculum. Whether the implementation of the NCTM standards in classrooms has a relationship to student anxiety about mathematics was studied. Student levels of mathematics anxiety as measured by the Mathematics Anxiety Rating Scale were correlated with teachers' scores on the "Standards" Beliefs Instrument (SBI). It was hypothesized that teachers with strong beliefs about the use and incorporation of the "Standards" would have students with lesser degrees of anxiety. Data were collected in the seventh and eighth grades at eight city and county schools in the Tuscaloosa (Alabama) area. Forty-one teachers completed the survey, along with one class of students for each teacher (782 students). Data in narrative form was also collected from five students who participated in in-depth interviews. There was no significant correlation between teachers' beliefs and students' mathematics anxiety. Nor was there any significant difference in the strength of their beliefs about the "Standards" between teachers who taught less than 5 years and those with more than 5 years experience. Much student mathematics anxiety was due to test anxiety. Implications for instruction are discussed. Two appendixes contain the beliefs instrument and a version of the mathematics anxiety scale. (Contains 6 tables and 142 references.) (SLD)

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MATHEMATICS TEACHERS' BELIEFS ABOUT USING THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS STANDARDS AND THE RELATIONSHIP OF THESE BELIEFS TO STUDENTS' ANXIETY TOWARD MATHEMATICS

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Introduction to the Study

A changing, economically competitive world, necessitated a need for reform in mathematics education. Research conducted by the Board of Directors of the National Council of Teachers of Mathematics (NCTM) in the mid 1980's indicated the mathematics curricula for elementary and secondary schools in the United States were not as effective as they could be. NCTM's response to the need for change was the publication of Curriculum and Evaluation Standards for School Mathematics (Standards) in 1989. NCTM felt standards would improve nationwide test scores in the area of mathematics. The NCTM Standards were established as a broad framework to guide reform in school mathematics (NCTM, 1989), not a specific curriculum. The NCTM's vision includes mathematics teachers encouraging students, probing for ideas, and carefully judging the maturity of a student's thoughts and expressions (NCTM, 1989). Most often current teaching practices in mathematics classrooms do not provide sufficient critical thought. The need for implementation of the Standards is essential. Often, teachers tend to teach the way they were taught. Sarason (1993) believes that any reform in education must first begin with teacher training.

Practicing mathematics teachers and preservice teachers thus need to be trained to implement these standards. Tobias (1993) agrees based on her work with math anxiety. Her research on the NCTM Standards shows its focus on teaching students to think for themselves and not constrained to rote memorization is the most significant attempt to improve the teaching of elementary school mathematics. Furthermore, if schools are going to improve the quality of teaching mathematics, then teachers themselves must believe in these Standards.

Mathematics anxiety in students has become a concern for our society. In the midst of a technological era, declining mathematics (math) scores on the Scholastic Aptitude Test (SAT) have been widely publicized. Golberg and Harvey (1983) have reported that American students rank last when compared with students from all other industrialized countries on 19 different assessments. In response, Gallup (1983) found the American public rated math first in importance when compared with the other academic fields. Educators, parents, politicians and others are trying to assess the cause for the apparent academic weakness of mathematics, and solutions to the problem are being sought. The National Council of Teachers of Mathematics in 1989 addressed this issue in Curriculum and Evaluation Standards in Mathematics. Hilton and Pedersen

(1983) contend math avoidance is a serious malaise of our time and that it has many causes which can be grouped under three headings: societal, familial, and cultural influences; pedagogy; and curriculum.

Even after the publication of the Standards in 1989, students continue to face the same problems in classrooms. When presented with math problems, some students find themselves anxious, distracted, and sweaty palmed (Tobias, 1978). Math anxiety has been found by Elliot (1983) to have physiological as well as psychological bases and has been found to have many correlates and manifestations (Frary and Ling, 1983). Clearly, mathematics anxiety is not the sole reason for low math achievement in this country; nevertheless, it is a critical academic problem, and educators should be informed of its nature as well as of its solutions. NCTM (1989) contends that when the learning of math is made relevant, students will find the subject more useful and will be less likely to fear it. The main question raised in this study is: Do teachers who use and implement the NCTM Standards in their classrooms minimize the risk of students having mathematics anxiety as compared to teachers who do not implement the Standards? Hence, this study will examine whether the implementation of the NCTM Standards in classrooms has a relationship to student anxiety toward mathematics.

Statement of the Problem

Declining national test scores in mathematics as well as increased attention to students' anxieties and dislike of mathematics raise a concern since these anxieties interfere with learning mathematics. One hope is that the implementation of the National Council of Teachers of Mathematics 1989 *Standards* can help to reduce mathematics anxiety. In this study, students' level of mathematics anxiety measured by the Mathematics Anxiety Rating Scale (MARS) will be correlated with teachers scores on the Standards' Beliefs Instrument (SBI). The SBI measures the level at which teachers believe in the use and incorporation of the NCTM Standards in their teaching. An analysis of the results will explore the relationship between teachers who rate high on their beliefs about using and incorporating the NCTM Standards and their students' level of mathematics anxiety.

Purpose of the Study

The purpose of this study is to determine whether there will be a relationship between test scores on the Standards' Belief Instrument (SBI) of mathematics teachers and the level of mathematics anxiety as measured by the Abbreviated Version of the Mathematics Anxiety Rating Scale. This study

will attempt to provide valuable information about mathematics teachers' use of the NCTM Standards and their effects on students' level of mathematics anxiety. As well, the study will provide some qualitative insights from students about their attitudes and anxieties about mathematics, which may be valuable information for educators to help improve the teaching and learning process of mathematics.

Significance of the Study

Recent research in mathematics education (Bush, Lamb, and Alsina, 1990; Fullan, 1983; Kesler, 1985; McGalliard, 1983; Silver, 1985; Thompson, 1984) indicates teaching behavior is profoundly or subtly affected by teachers concepts of the definition of mathematics. For example, Thompson (1984) found that mathematics teachers' opinions, beliefs, and inclinations swayed their instructional practices. Thus, many inappropriate teaching methods could be attributed to teachers' tenets about teaching (Ferrini-Mundy, 1986). Desper (1988) determined that prevention of mathematics anxiety begins with the teachers and that teaching strategies which build positive and realistic self-concepts can prevent the development of mathematics anxiety in students. Berebitsky (1985) claims that often times teachers suffer themselves from mathematics

anxiety. Hence, teachers' own awareness about their teaching beliefs and how they impact students' attitudes toward mathematics is critical. If research can support the use of and implementation of the NCTM Standards in the curriculum, this study can serve to link this into reducing mathematics anxiety, schools will then have the knowledge to improve students' mathematical preparation.

Research Hypotheses

The research hypotheses examined in this study deal with students and how their mathematics anxiety relates to their mathematics teachers' beliefs about the use and incorporation of the NCTM Standards in their mathematics instruction. Hence, it is hypothesized that mathematics teachers who have strong beliefs about using and incorporating the NCTM Standards in their instruction will have students who experience less anxiety about mathematics. There are three hypotheses in this study comparing: (a) teachers' beliefs about the use of the NCTM Standards and its correlation with students' level of mathematics anxiety; (b) grade level (seventh-grade mathematics students and eighth-grade mathematics students), sex (male mathematics students with female mathematics students), and teachers' beliefs about the NCTM Standards with student level of mathematics anxiety; and (c) teachers with five years or

less teaching experience with teachers who have more then five years of teaching experience on the Standards' Beliefs Instrument. The measure of mathematics anxiety in the students in this study is determined by the Mathematics Anxiety Rating Scale Abbreviated Version (MARS)(Alexander and Martray, 1989). The measure of teachers' beliefs about the use of the NCTM Standards will be determined by the Standards' Beliefs Instrument (SBI) (Zollman and Mason, 1992). The statements of the research hypotheses are the following:

Hypothesis 1: There is a correlation between: (a) the extent of teachers beliefs about using and incorporating the NCTM Standards (as measured by the Standards' Beliefs Instrument) and (b) the level of mathematics anxiety of their students (as measured by the Abbreviated Version of the Mathematics Anxiety Rating Scale).

Hypothesis 2: There is a significant interaction among grade level (7 and 8), gender, and teachers' beliefs about the use of the NCTM Standards (as measured by the SBI) with students' level of mathematics anxiety (as measured by the abbreviated version of the MARS).

Hypothesis 3: There will be a significant difference on the Standards' Beliefs Instrument scores of teachers with five years or less of teaching experience to teachers with more than five years of teaching experience.

Limitations of the Study

The following are considered to be limitations of the study:

(a) This study is limited to seventh- and eighth-grade students and teachers in both the City and County Schools of Tuscaloosa, Alabama, and thus, may not be generalizable to other settings;

(b) The relatively small sample size limits the generalizability of this study;

(c) The honesty of participants' answers to questions is assumed; and

(d) It cannot be told whether teachers actually used the NCTM Standards; only their attitudes and beliefs were measured using the SBI.

Assumptions of the Study

The use of intact, seventh- and eighth-grade mathematics classes assumed that each middle school used the same criteria for grade level placement. It is assumed that there are varying levels of teachers' beliefs on the Standards' Beliefs Instrument and that there are teachers currently using and incorporating the NCTM Standards to some degree in their classroom instruction. Lastly, it is assumed that the one class of seventh- and eighth-grade students from each teacher in the study will provide data

about the students' level of math anxiety; this may also be a reflection of other classes that each teacher teaches.

Review of Related Literature

Evidence of students' poor attitudes and high levels of anxiety toward mathematics is abundant. This study reviewed published research on several variables that relate to the formation of students' anxieties toward mathematics. These include teachers' beliefs, the NCTM Standards, society's attitudes toward mathematics, causes and reasons for mathematics anxiety, and students' perceptions toward teachers. A discussion of the relationship between mathematics anxiety in students and how teachers teach also is presented. In addition, research regarding the measurability of students' anxieties toward mathematics is cited, and information regarding specific instruments is included.

The National Council of Teachers of Mathematics Standards

Research concerning mathematics teachers' beliefs about the use and need for the NCTM Standards was introduced by Zollman and Mason (1992) after they designed and tested an instrument that they named the Standards Belief Instrument

(SBI). Zollman and Mason developed the SBI in order to test mathematics teachers' attitudes toward teaching according to the 1989 NCTM's Standards. The goal of the SBI was to develop an instrument which could be used to assess the beliefs of teachers about the NCTM Standards. The SBI was specifically developed to measure mathematics teachers' beliefs according to the NCTM Standards. The SBI provides for a myriad of implications for teaching mathematics. In order to provide a basis for understanding the implications for teaching the NCTM Standards, research related to mathematics teacher preparation, teacher beliefs, attitudes toward mathematics education, and the implementation of the NCTM Standards have been included. Finally, they contend an important relationship exists between the teacher's beliefs and the teacher's own style of teaching. Therefore, wide acceptance of the NCTM Standards could hinge on teachers' beliefs (Zollman & Mason, 1992).

Research on the NCTM Standards

Researchers continue to emphasize the need to reform teacher education to promote a corresponding transformation in mathematics instruction in today's schools. Sarason (1993) believes that if one wants to change the education of students, one needs first to change the education of their teachers. Hence, it is necessary to prepare educators for what life is like in classrooms, schools, school systems,

and society. Sarason believes that in the case of reform, educators first need to focus on preparing teachers differently. The NCTM Standards can act as a genesis for this preparation (NCTM, 1989). Pejouhy (1990) has advocated the implementation of the NCTM Standards and how they may impact and reduce the level of math anxiety students currently feel with more traditional approaches toward teaching mathematics. Pejouhy (1990), however, has found that math teachers tend to be resistent to making changes in the math curriculum recommended by the National Council of Teachers of Mathematics. The preservice and continuing education of teachers of mathematics should provide teachers with opportunities to examine and revise assumptions about how mathematics should be taught and how students learn mathematics (NCTM, 1989; NCTM, 1991; and NCTM 1995). Thus, preservice mathematics teachers need to prepare for teaching in the next century.

Beliefs about The Standards

Gadanidis (1994), in his article, "Deconstructing Constructivism," claims that teachers must have an understanding of the NCTM theory before they are able to put the theory into practice. This idea reflects the NCTM's Professional Standards for Teaching Mathematics (1991) contending, the final success for any teacher is the

integration of theory and practice. NCTM (1995) also published a document on assessment in mathematics.

O'Laughlin (1990) found that beginning teachers maintain definite beliefs in regard to knowing, learning, and teaching, which usually lead them to endorse didactic approaches in which the teacher acts as the primary conveyer of knowledge. A teacher's beliefs about students' abilities greatly influence the decisions the teacher makes about the learning environment (Lubinski, 1994). Lubinski (1994) feels that teachers who believe the content of mathematics in their classrooms is guided by the textbook make different decisions than do teachers who believe that the content of mathematics is guided by students' interests and ability. Research indicates that teachers' beliefs and teachers' knowledge are related to the instructional decision making process (Fennema and Franke, 1992; Parares, 1992; Thompson, 1992). Merseth (1993) asserts that teacher's beliefs can "profoundly influence" their pedagogical practices in teaching mathematics. Therefore, what a teacher believes about teaching and learning mathematics and what a teacher knows about the content, methods, and materials available to teach mathematics, influence the teacher's instructional decisions.

Research related to the issue of attitudes toward mathematics education is extensive. In addition, the NCTM Standards recognize that mathematics has become extremely important in today's world (NCTM, 1989). One of the most important factors in developing students' mathematics ability is the attitude of their teacher toward the discipline (Meyer, 1980).

Tobias (1993) claims that the Standards promise to present mathematics as a thinking and decision making tool. It directs teachers to begin with concrete materials, instead of meaningless abstractions, to get students to see that math makes sense in their everyday experience. The new Standards call for: the teaching of how to think for oneself, working in groups at all levels of math, efficiently using technology, the teaching of estimation, more statistics and probability in beginning grades, less computational drill and practice, the use of manipulatives, and more realistic problems. Tobias feels that using an approach consistent with the NCTM Standards to teach mathematics helps to convey the message that mathematics is first and foremost a language, and that the point of all the material we had to learn was to provide us with a way of organizing information so that we could make better decisions in our lives (Tobias, 1993).

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There is extensive research on teachers' beliefs about mathematics instruction. Hersh (1986) reminds us of this and raises some important questions:

> One's conceptions of what mathematics is affects one's conception of how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it... The issue, then, is not, What is the best way to teach? but, What is mathematics really all about? (p.13)

Ultimately then, it is important to note that each teacher's beliefs and conceptions about how to teach math relate to one's experiences and what one deems most essential when teaching mathematics.

Inservice and Preservice Teacher Training about the NCTM Standards

The knowledge of the students' thinking is very important. Teachers' knowledge of mathematics content and pedagogy is also critical to the culture of the learning environment. Lubinski (1994) feels that teachers need to design blueprints for worthwhile mathematics tasks which consider both the knowledge of the content and pedagogy in conjunction with their students' prior knowledge.

Research has shown that it is critical for successful student learning and the development of positive attitudes about math that secondary mathematics teachers have strong mathematical knowledge, a positive attitude toward mathematics and teaching, as well as an alignment with

proper pedagogical beliefs (Battista, 1994; Burns, 1994; Kerr and Lester, 1982; Meyer, 1980). It is believed that mathematics education majors have not been exposed to enough alternative teaching methods to be capable of teaching mathematics with an emphasis on understanding (Ball and Wilson, 1990). Ball and Wilson (1990) discovered that preservice secondary mathematics teachers often lack sufficient mathematical understanding to teach the subject effectively. Farrell and House (1994) believe that prospective mathematics teachers must construct knowledge about teaching, and in the process, they frequently must reconstruct their knowledge of mathematics. In 1991, the National Council of Teachers of Mathematics along with the Association for Supervision and Curriculum Development published A Guide for Reviewing School Mathematics Programs. In this document they claimed in order to have high-quality mathematics programs, teachers of mathematics must be well prepared, process and demonstrate positive attitudes, continue to grow professionally, and be actively involved in educational issues that affect the quality of their students' learning (NCTM and ASCD, 1991).

The research conducted on the implementation of the NCTM Standards has been immense since its publication in 1989. The NCTM Standards present a picture of classroom instruction different from present practice in secondary

schools. The implementation of the Standards involves a restructuring of mathematics instruction, which involves the implementation of the NCTM Standards, for both preservice and inservice mathematics teachers (Parker, 1991). One professor of secondary mathematics education found she needed to change her teaching pedagogy in order to incorporate the NCTM Standards. She found that, despite strongly prepared mathematics students, they experienced a great amount of trauma as a result of learning mathematics in new ways. Her teaching techniques, including the NCTM Standards, consisted of cooperative activities with manipulatives such as geoboards, tangrams, algebra tiles, and technology (Farrell and House, 1994). Farrell and House (1994) contended that incorporating the NCTM Standards helped the students learn mathematics in a new way, providing models for the future mathematics educators to teach themselves. Hence, for preservice mathematics teachers to incorporate the Standards, they must learn mathematics in a new manner in which they construct this new knowledge and understanding based on prior knowledge and if necessary, in a concrete manner in order to teach students effectively using this approach. The Standards document recommended a departure from conventional forms of instruction and evaluation and a more wholistic approach to conveying the content knowledge. Other researchers believe

that there must be a link between pedagogy and mathematics, and that during preservice teacher training, the students must have a hands-on approach in their math methods course in order to implement the Standards fully (Cooney and Friel, 1992). Edgerton (1992) contends, after observing inservice teachers implementing the Standards, it is going to take considerable time to see any significant results from the use of the Standards. Both inservice and preservice teachers are so accustomed to the way they were taught, that for them to teach mathematics in another way is going to take both time and experience. The implementation of the Standards can be seen as an effort that demands a great deal of teacher training as well as changing teachers' beliefs as a means for full incorporation of the Standards in mathematics classrooms. Currently, the standards are slowly being implemented in a fragmented manner (Edgerton, 1992).

Mathematics Anxiety in Students

Mathematics anxiety has been a prevalent concern among educators and others in our society for decades. Now, with the advent of computer technology, the need for the understanding of mathematics is critical. Teachers can play an important role in reducing the level of mathematics anxiety in their students. McLeod (1991) claims that affective factors play a central role in mathematics

learning and instruction. There are many aspects to mathematics anxiety. Math test anxiety, number anxiety, and math course anxiety will be examined in this study.

Causes for math anxiety, according to Hackett (1985), varied from socioeconomic status and parental background to the influence of teachers and school system. Kutner (1992) asserts that teachers and parents who are afraid of math can pass on math anxiety to the next generation, not genetically, but by modelling behaviors of their own discomfort with the subject. Oberlin (1982) discussed the following teaching techniques as causes of math anxiety: (a) assigning the same work for everyone; (b) covering the book problem by problem; (c) giving written work everyday; (d) insisting on only one correct way to complete a problem; and (e) assigning math problems as punishment for misbehavior. Brush (1981) contends that the development of math anxiety carries some symptoms which include: (a) mathematics become difficult during early years of school; (b) students spend excessive amounts of time relearning what they were taught in past years; and (c) students are not exposed to the everyday applications of the material covered.

Crawford (1980) found that a student's lack of success with math may be caused by any one of several factors: a poor math instructor at some point, an insufficient number of math courses in high school, intelligible textbooks, or

misinformation about what math is and what it is not as well as who should do well in math. Crawford also found that many people often blame their failures on their lack of a mathematical mind, the notion that men are better than women at math, or that they have poor memories or learning disabilities rather that any of the others mentioned. Tobias (1987) contends that there are two myths about mathematics that need to be eliminated. One is higher-level math is too difficult for otherwise intelligent students to master, and another is without mathematics you can live a productive intellectual and professional life. Students must overcome any fears of mathematics and be challenged to take higher-level math courses. One reason is it may reflect on their career choices in the future if they do not.

There is also an immense body of literature and research on practices to reduce and prevent mathematics anxiety. A study by Reilly (1992) examined the relationship between math anxiety and selected demographic characteristics. Surveys were administered to 1,152 students in vocational-technical and comprehensive schools in 13 New Jersey school districts. The survey instrument included an attitude scale and a brief math test designed to evoke feelings of mathematics anxiety in respondents. The responses of single parents and students enrolled in

nontraditional career preparation programs were compared to those of students with both parents enrolled in comprehensive high schools. The single parents and students enrolled in nontraditional programs expressed higher levels of math anxiety than did their two parent counterparts enrolled in traditional career preparation programs. Level of mathematics anxiety was significantly related to the following variables: age, parental status, marital status, race, income level, mother's occupation, and previous mathematics courses taken. Reilly (1992) reported that students whose mothers were not employed outside the home exhibited the lowest levels of mathematics anxiety, thus confirming the importance of home participation and support to student success in mathematics. Hence, past experiences with mathematics, messages from society, and messages from school all greatly impact a students' confidence and ability to do math (Davidson and Levitov, 1993).

Selye (1956, 1979) contends there are two types of stress: eustress and distress. Eustress is inevitable and can be motivating, while excess stress and the destructive aspects of distress are preventable or at least can be minimized most of the time. The relaxed-alert brain/mind functions best both for initial learning and for retrieval of information. High levels of thought, creativity, and other intuitive processes require conditions of low tension

in order for learners to be motivated (Selye, 1956). Davidson and Levitiv (1993) have created what they call the anxiety cycle. They believe that students continue in a cyclic manner with math anxiety until they are cured. The math anxiety cycle includes the following: beginning with the under or over preparation; to taking a math test; to the student feeling anxious; and finally to the student doing poorly on the test. Hence, much of the anxiety that exists stems from the perceived poor performance on math tests.

Anxiety and the Role of the Mathematics Teacher

A great deal of the research has shown that there are variable factors that contribute to student anxiety toward mathematics. According to Williams (1988), mathematics anxiety has its roots in teaching and in teachers of mathematics. Williams believes that since people generally are not math anxious before going to school, math anxiety is related to the teaching of mathematics. It is thought the notion that mathematics is something to be dreaded begins in the child's first years in school. Teachers and other significant adults model that mathematics is difficult and something to fear, while at the same time indicating mathematical skills are very important for their future success. It is important to keep in mind the first exposure children have doing math will be with their primary teachers

who, more than likely, are not trained in math and who are also anxious about math (Posamentier and Stepelman, 1986; Harper, 1994). Wells (1994) has identified anxiety as a major factor in blocking students' reasoning, interference with memory, the understanding of general concepts, and an appreciation for mathematics.

Tobias (1993) contends that one major problem is math is often times taught in discrete bits by teachers, who themselves were taught this way. No real connections are made for the learners. When students "don't get it," they tend to give up or feel they can never succeed at math. Another problem for students occurs when teachers rely heavily on right and wrong answers. Too often, teachers, wanting to reward accuracy, tend to go overboard treating errors as occasions for shame. Tobias (1993) reports that too often, teachers play a role in spreading a vicious myth that math ability is inborn and that not all students are good in math. Good and Brophy (1994) address this issue and relate it to how teachers communicate expectations to students. The self-fulfilling prophecy effect can be extremely powerful in effecting the attitudes and success of students.

Bush (1991) has found in research on math anxiety in upper-elementary grades that math anxiety is not transmitted from teachers to students. Bush has also found that

significant results have indicated that increased anxiety is related to increases in time spent on review and decreases in math anxiety when students work in small groups.

The National Resource Council (NRC) in 1989 reported that 75% of all jobs require proficiency in basic algebra and geometry as a prerequisite for licensure or training. Arems (1993) contends teachers play a major role in their students' career choice selections. More than ever, Americans need to think for a living and think mathematically. Math teachers need to do what they can both to influence students and teach them the importance of math. Also, it is important to provide students with optimal learning experiences to understand the concepts related to mathematics in an environment where little or no math anxiety is perpetuated.

Posamentier and Stepelman (1986) suggest that the signals projected by a teacher should be considered when a teacher is forced to teach mathematics, but who would rather not: math would be presented in somewhat of a strained tone of voice; it will be presented as an arduous task for both the teacher and the students which must be completed in the shortest time possible; it will be taught as a drill /memorization exercise rather than a thinking/problem-solving agent; and it will be readily used as a punishment. This form of instruction would certainly be enough to scare

students and it is understandable why and how so many young adolescents begin their first junior high math class in a cold sweat (Posamentier and Stepelman, 1986). Often, math is taught by teachers who do not like math, claims Posamentier and Stepelman (1986). Frequently students' first real encounters with math are that it makes them feel stupid if it is presented by teachers who do not like math, and when they go home, usually they find that their parents do not like it either. Posamentier and Stepelman (1986) contend most junior high and senior high mathematics teachers are not prepared to deal with this psychological fear of math, nor are they prepared to deal with the defense mechanisms and strategies their students use to protect themselves from appearing to fail in math.

Summary

The review of literature has provided information concerning the attitudes, content knowledge, pedagogy, beliefs, and students' mathematics anxiety regarding the implementation and use of the NCTM Standards. This body of research indicates that there is a great deal of knowledge regarding how a teacher's beliefs, knowledge, and pedagogy affect the way in which one actually teaches. The NCTM Standards address the issues facing today's young people and a means to make mathematics more meaningful. The new

generation of teachers can act as the Greek god, Hermes, the god of sending messages and news, on what research has shown to be better approaches for teaching mathematics. This study attempted to add to this body of knowledge by investigating the effect of mathematics teachers' pedagogical beliefs about using the NCTM Standards and the relationship of those beliefs to their students' levels of mathematics anxiety.

Methods, Presentation, and Analysis of Data

Introduction

The purpose of this study was to consider the effects of seventh- and eighth-grade mathematics teachers' beliefs about the NCTM Standards and the level of math anxiety of their students. In this section, the results of the statistical tests performed on the quantitative hypotheses are discussed. The results of some qualitative investigation was also examined in order to give a more well rounded depiction of students' mathematics anxiety.

The data presented are: (a) results of Pearson Correlation of teachers' scores on the Standards' Beliefs Instrument (SBI) and the Abbreviated Version of the Mathematics Anxiety Rating Scale; (b) results of a General

Linear Models Procedure (three-way ANOVA) showing comparisons of student gender, grade level, and teachers beliefs according to their scores on the SBI; (c) results from the ANOVA comparison on the SBI between teachers teaching less than five years with teachers teaching five years or more; (d) results from other survey data; and (e) narrative biographies from interviews by the five students who participated in the case study interviews from August, 1995 to January, 1996. All subjects' names mentioned in the analysis are not the actual names of the subjects; they are pseudonyms.

Data were collected at eight city and county schools in Tuscaloosa, Alabama, which consisted of seventh and eighth grades, using the Abbreviated Version of the Mathematics Anxiety Rating Scale (MARS; Alexander and Martray, 1989) on the students and the Standards' Beliefs Instrument (SBI; Zollman and Mason, 1992) on the teachers. The Abbreviated Version of the MARS is a 25-item inventory which assessed anxiety toward mathematics on three scales: test anxiety, number anxiety, and math course anxiety. The SBI is a sixteen-item instrument which assesses teachers' beliefs about using the NCTM Standards in their mathematics classrooms.

Description of Data

The collection of the survey data took place during the first week of February, 1996. Of the 49 teachers asked to participate in the study, 41 actually completed the teacher survey along with one class of their students. Some special education teachers who teach math and a few ninth-grade teachers were given the survey by the researcher without knowing the exact status of their grade level and/or level of ability. There were 34 female teachers and seven male teachers who participated in this study. Class sizes ranged from six to 28 students. All students in the study were chosen according to their math teachers' participation; they were given the MARS at the same time as the teachers. Surveys were returned by 782 students along with their teachers' survey. In the student population, 371 were females and 401 were males, and 397 were seventh-graders and 375 were eighth-graders. Students exercised their option not to take the survey by turning in a blank or incomplete form. Only ten student surveys were invalidated because less than one half of the items were completed, because random responses were left blank, because incorrect markings related to gender and grade level, or because of multiple responses on statements.

Each SBI and MARS, after collection from the eight schools, was sorted by teacher and student and scanned into

the computer. Computational programs were written in SAS (SAS Institute, Inc., 1985) for each set of data, and mean scores and standard deviations were computed. The programs were merged to compute a Pearson Correlation for Null Hypothesis 1, a three-way ANOVA for Null Hypothesis 2, and an ANOVA for Null Hypothesis 3.

The collection of data from the five students who participated in the case study interviews is in narrative form. The interview data were collected during the Fall, 1995, and the Winter, 1996. The data are expressed in narrative form depicting each subjects views and feelings about mathematics. The researcher has tried to tell a story of each student's experiences with mathematics over their lifetime. The researcher looked for possible causes of math anxiety and also potential methods in which students feel teachers can help to reduce math anxiety. Each subject's story is unique to himself/herself. The levels of math anxiety may vary from each student, some displaying very little anxiety and others a significant level of math anxiety.

Testing of the Research Null Hypotheses

Null Hypothesis 1: There is no correlation between: (a) the extent of teachers beliefs about using and incorporating the NCTM Standards (as measured by the Standards' Beliefs

Instrument) and (b) the level of mathematics anxiety of their students (as measured by the Abbreviated Version of the Mathematics Anxiety Rating Scale).

A mean score for the 772 students on the MARS was 57.90 and the mean score of the 41 teachers on the SBI was a 43.07, as can be seen in Table 1. Correlating the mean scores between the SBI and the MARS found a Pearson Correlation Coefficient of -0.13812 with a probability of 0.3891 (see Table 2), indicating no correlation between the two groups of mean scores; therefore, no correlation existed and the null hypothesis was not rejected.

Table 1

Descriptive Statistics for Null Hypothesis 1

Variables	n	M	SD	Sum
MARS (Students)	772	57.91	18.57	44704
SBI (Teachers)	41	43.07	3.94	1766

Table 2

Pearson Correlation Coefficients for Null Hypothesis 1

	MARS (Students) N=772	SBI (Teachers) N=41
MARS (Students)	1.00000	-0.13812
	0.0	0.3891
	772	41

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Null Hypothesis 2: There is no significant interaction among grade level (7 and 8), gender, and teachers' beliefs about the use of the NCTM Standards (as measured by the SBI) with students' level of mathematics anxiety (as measured by the abbreviated version of the MARS).

To test this null hypothesis, a 3-way ANOVA Procedure was used to test the dependent variable, MARS mean test scores with students' gender, grade level, and teachers' score on the SBI. The teacher's scores on the SBI where grouped into two categories: category 1 contained teachers with overall mean ratings less than or equal to 43.07 on the rating scale and category 2 containing teachers scoring higher than 43.07 or higher on the SBI (see Table 3).

There were no statistically significant findings in Null Hypothesis 2 between the dependent variable (MARS) and grade level and with the two categories of teachers' beliefs mean scores. However, there was an interaction effect between gender and grade with a $p >$ value of .0275 which called for a Cell Means Procedure. The procedure indicated that the eighth-grade females had a significantly higher mean (61.48) than eighth-grade males (55.45). The null hypothesis for this interaction was rejected. No significant difference was found, however, between seventh-grade males (57.61) and females (57.77).

Table 3

Three-Way ANOVA Procedure used for Null Hypothesis 2

Dependent Variable: MARS (Students)

Source	df	SS	F Value	Critical F
Model	7	5534.57	2.32	0.0240
Error	764	260320.72		
C. Total	771	265855.28		
Student Gender	1	1531.91	4.50	0.0343
Student Grade	1	97.71	0.29	0.5925
Gender*Grade	1	1646.7834	4.88	0.0275
SBI Lev	1	1021.4793	3.00	0.0838
Gender*SBI Lev	1	122.2759	0.36	0.5493
Grade*SBI Lev	1	661.8740	1.94	0.1638
Gender*Grade*SBI	1	229.5449	0.67	0.4120

Null Hypothesis 3: There is no significant difference between the Standards' Beliefs Instrument scores of teachers with five or less years of teaching experience and those of teachers with more than five years of teaching experience.

In order to test this null hypothesis, an ANOVA was completed to test this null hypothesis at the $p < .05$ level of significance (See Table 4). The assumptions of (a) random samples, (b) normality, (c) homogeneity of variance, and (d) independent groups were met. In comparing the SBI scores, teachers were placed into two categories: category 1 consisted of teachers teaching four years or less and category 2 consisted of teachers teaching more than four

years. The results of this test indicated no significant difference with a p value of 0.1012 and an F value of 2.82. Thus, the null hypothesis was not rejected. Interestingly, teachers with less than five years of teaching experience (eight teachers) had a slightly higher mean score (45.13) than the teachers teaching (33) five or more years (42.58).

Table 4

Analysis of Variance Procedure for Null Hypothesis 3

Dependent Variable: SBI (Teachers)

Source	df	SS	MS	F Value	Critical F
Model	1	41.845	41.845	2.82	0.1012
Error	39	578.936	14.845		
C. Total	40	620.780			
Years Teaching Category	1	41.845	41.845	2.82	0.1012

Additional Survey Statistics

The researcher also conducted some additional survey statistic collected from both the teachers' and students' data in this study. The statistics collected were from the demographic portion of both the student and teacher surveys as well as the instruments themselves. These additional statistics will help the researcher to draw more conclusions related to this particular study.

The researcher computed the mean rating on the Abbreviated Version of the MARS for each of the three subscales: test anxiety, number anxiety, math course anxiety. It was found that the test anxiety subscale ranked

the highest (2.518) when being answered overall by students. The number anxiety subscale (1.955) and the math course anxiety subscale (2.073) ranked lower. This indicated that overall, students scored higher in the area of having more test anxiety than number anxiety or math course anxiety.

Table 5 provides a frequency of the teachers' responses to the SBI broken down into two categories: category 1 includes teachers teaching 4 years or less and category 2 includes teachers teaching more than four years. The table reflects how the two groups of teachers rated each of the sixteen items on the SBI (see Appendix A). It was also found that teachers' scores on the SBI ranged from a low of 31 to a high of 52.

Table 5

Frequency Count By Years of Teaching Per Item on the SBI

Item	Strongly Disagree		Disagree		Agree		Strongly Agree	
	4 or <	5 or >	4 or <	5 or >	4 or <	5 or >	4 or <	5 or >
- 1	3	8	3	14	2	8	0	3
+ 2	0	0	0	1	2	22	6	10
+ 3	0	0	0	0	1	18	7	15
+ 4	1	0	1	1	4	20	2	12
- 5	4	7	2	21	2	5	0	0
+ 6	1	1	1	0	3	21	3	11
- 7	3	3	4	20	0	8	1	2
- 8	0	1	1	8	5	21	2	3
- 9	0	0	0	1	6	22	2	10
-10	0	1	3	0	5	23	0	9
-11	0	0	3	5	5	23	0	5
-12	0	0	1	4	7	26	0	3
+13	0	1	1	14	5	13	2	5
+14	1	9	4	13	3	8	0	3
+15	0	1	0	0	5	18	3	14
+16	1	2	4	10	3	19	0	2

(-) symbolizes a reversed item. See the Standards' Belief Instrument in Appendix A.

Lastly, in the student demographic section of the MARS, students were asked to rate their favorite subject, their least favorite subject, and what they liked their teachers to do as far as teaching approach. The students were asked to mark their two favorite subjects out of a category of: English, Social Studies, Foreign Language, Science, and Mathematics. The frequency counts of the students' ratings on their favorite subjects were as follows: Science (425), English (334), Mathematics (322), Social Studies (298), and Foreign Language (116). Science appears to be the favorite subject among the students by a wide margin. Not all schools offer foreign language courses for students at the

middle school level. Students were also asked to rate their two least favorite subjects using the same rating categories. The following findings of students least favorite subjects were: Social Studies (378), English (362), Mathematics (283), Science (255), and Foreign Language (217). All scores appear to be consistent with the scores related to their favorite subject. The students in the study were also asked to complete as part of their demographic information what two things they like their math teacher to do from the following categories: Lecture, Hands-on Activities, Group Activities, Computer and Calculator Activities, and Quiet Seat Work. The following results indicated Group Activities scored highest with a frequency count of (404), followed by Calculators and Computers (353), then Hands-on Activities (241), Quiet Seat Work (173), and lastly, Lecture (130). Interestingly, group activities, hands-on activities, and calculators and computer activities all rank higher and all are highly recommended by the NCTM Standards.

Qualitative Component of this Study

In this study, five students were chosen to be interviewed three times each in order that the researcher may both reinforce and humanize this study. Each student was interviewed three times over a six-month period of time.

Names used in the analysis are not the actual names of the subjects; they are pseudonyms. The students were selected randomly and may or may not have math anxiety or their levels of math anxiety may vary. The interview questions that were used came from several sources (Kitchens, 1995; Tobias, 1987; Ruedy and Nirenberg, 1990). All interviews were conducted for approximately 10- to 15-minutes in length and were audiotaped. The answers were used to assess students' level of math anxiety. They also probed students' perceptions of effective mathematics instruction and examined reasons why they may perhaps have fears and anxiety toward math. For the sake of this paper, each student is presented by a quote. For original full length case studies see Furner (1996).

Case Study Student Quotes

Julie

"I really don't like math, but I do okay."

-Julie

Brian

"I just don't like math, its the same thing and big numbers, I don't like big numbers."

-Brian

Juakila

"Math is pretty simple for me....I don't study much for tests, but I still pass."

-Juakila

Jose

"I do fairly well in math....It is enjoyable for me."

-Jose

Jill

"I am good in math at some points and not so good in others, like algebra. I've tried it. I want to go to a summer program, like Shelton to take a math class in the summer, I told my mom this."

-Jill

Analysis of Case Study Data

Based on the acquired data from the case studies the following implications for the classroom can be deduced to fit into two categories: situations that cause math anxiety and situations that alleviate math anxiety. These two categories were chosen as they reflect the purpose of the study which was to look at teachers' beliefs about teaching mathematics and its effects on students' levels of math anxiety. The data collected in the case studies provides rich descriptive details from the students about their math attitudes. The themes that were generated from all five case studies are discussed in the next two paragraphs. Table 6 provides a summary of the case study comments.

It was clear from the five case study biographies that the students felt that the following situations caused math

anxiety for them: being called to the board (Brian); made to feel bad for wrong answers or not doing a problem the "right" way teachers want you to(Brian, Jill, and Juakila); timed tests; paper and pencil type tests (all students); drill and practice (Brian); the use of large numbers in math problems (Brian); teachers being boring, showing no expression, or talking in a monotone voice (Jose, Julie, Juakila, and Brian); past experiences with failure in lower/prior math classes (Brian and Juakila); not talking about feelings and attitudes about math and what they are learning (all students); skipping math or having less of an emphasis in the elementary grades (Jose); and lack of mastery in a topic (Jill, Brian, Juakila, and Jose). Many of the findings from the case studies are supported in the research from the literature review. The causes for math anxiety found in the case studies will be used to support the quantitative findings.

The five students during their interviews shared many interesting thoughts on factors that help to alleviate math anxiety based on their experiences. The students suggested the following factors as important for alleviating math anxiety: math games (all students); hands-on activities (Juakila and Brian); teacher personality type/personal

Table 6

Summary of Case Study Comments

Students	Julie	Brian	Juakila	Jose	Jill
Grade Level	8	7	8	8	7
Math Grades Receive	A & B	C,D, & F	B	A & B	A
Student Stated Level of Math Anxiety	none	some	none	some	none
MARS Score	41	64	72	36	29
Teaching Strategies Liked	Group Work Worksheets	Games Quiet	Games	Games Detailed Instr.	Games Direct Instr.
Topics Liked in Math	Fractions	Word Problems Factors	Greatest Common Problems	Fractions Word	Number Theory
Feelings on Current Math Teacher	Ambivalent	Neutral	Likes	Likes	Likes
Math History	Good	Bad 2nd-7th Grades	Good Except 5th Grade	Good Except 5th Grade	Good Except 5th
Test Anxiety	Little	A lot	some	some	Little
Homework	Does	little	little	does	does
Usefulness of Math	Very	Very	Very	Very	Very
Interest in Math	none	none	some	some	some
Math Confidence	Some	None	Some	Some	A lot

connections with the teacher (Jill, Juakila, Jose, and Julie); being involving and interesting (all students), discussions in classrooms (Jill); not embarrassing students

(Brian, Jill, and Juakila); and not having just one right way to solve problems (Julie). This information will be used to support the quantitative results in Chapter V.

Summary

The analysis indicated that: (a) there was no significant correlation between teachers' beliefs about the NCTM Standards and the level of mathematics anxiety of their students; (b) there does exist a slightly higher level of mathematics anxiety in eighth-grade females over eighth-grade males, but there is no difference between grade level or whether the teacher scored above or below the SBI mean score; and (c) there is no significant difference between teachers who have taught less than five years over teachers who have taught five years or more on their beliefs about the NCTM Standards according to the SBI.

Also, an overall mean rating on the MARS for each of its three subscales: test anxiety, number anxiety, and math course anxiety were computed. The results indicated that test anxiety rated higher than number anxiety and math course anxiety.

In some instances, students displayed little, none, or a great deal of math anxiety. Each individual study presented a unique depiction about mathematics anxieties. There were various elements which initially contributed to

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each subject's level of math anxiety, including negative experiences with former mathematics teachers, particular mathematics topics, or particular teaching methodologies in past mathematics classes. The analysis of the case studies categorized the findings into two areas: causes of math anxiety and practices that alleviate math anxiety.

Findings, Implications, and Conclusions

This has been a study of seventh- and eighth-grade mathematics teachers' beliefs about the NCTM Standards and the influence these beliefs have on the levels of mathematics anxiety that their students experience. The purpose of this study was to determine whether teachers' beliefs on the SBI would have any correlation to their students' level of mathematics anxiety on the Abbreviated Version of the Mathematics Anxiety Rating Scale. The study also examined whether there were any interactions or relationships between the teachers' beliefs about the Standards and their students' scores on the MARS according to gender and grade level. The SBI was also used to see whether new math teachers who have recently graduated from a mathematics teacher education program had beliefs about the Standards that produced higher mean scores than teachers who

have been teaching for five years or more. This study investigated several factors related to mathematics anxiety including what math teachers can do in their classrooms, what is causing mathematics anxiety, and the relationship between math anxiety and test anxiety in the mathematics classroom. The research hypotheses addressed were:

1. Hypothesis 1: There is a correlation between: (a) the extent of teachers beliefs about using and incorporating the NCTM Standards (as measured by the Standards' Beliefs Instrument) and (b) the level of mathematics anxiety of their students (as measured by the Abbreviated Version of the Mathematics Anxiety Rating Scale).

2. Hypothesis 2: There is a significant interaction among grade level (7 and 8), gender, and teachers' beliefs about the use of the NCTM Standards (as measured by the SBI) with students' level of mathematics anxiety (as measured by the abbreviated version of the MARS).

3. Hypothesis 3: There is a significant difference between the Standards' Beliefs Instrument scores of teachers with five or less years of teaching experience and those of teachers with more than five years of teaching experience.

Based on the findings from this study, the researcher feels three important considerations for the way math teachers teach mathematics have been revealed. This study suggests that teachers should employ varied forms of

assessment in mathematics instruction, and that an eclectic approach to testing appears to be the means for students' diverse styles of learning and thinking. For many students, in order to lessen math anxiety, less of an emphasis on timed and paper and pencil testing is needed. The need for math teachers to openly discuss students' feelings about mathematics and to teach students techniques for coping with and reducing math anxiety is also supported. And lastly, teachers need to overcome gender-stereotyping of mathematics and work to see that equity exists within the classroom for both females and males alike.

Findings and Conclusions

The first hypothesis tested for a correlation between teachers' scores on the SBI and their class of students' scores on the MARS. The aspects of whether teachers' beliefs about the NCTM Standards would effect students' level of mathematics anxiety may be supported by Hembree's (1990) meta-analysis on mathematics anxiety. Hembree found that there are ways of both reducing and preventing mathematics anxiety; regardless of what a teacher does instructionally for a student who has math anxiety, the only effective means to reduce a student's math anxiety is through systematic desensitization. Any student experiencing math anxiety in this study perhaps would

benefit from techniques for dealing with the anxiety. These techniques include: proper breathing, optimistic visualizations, positive affirmations, and the discussing of feelings about mathematics. There is reason to believe that math teachers need to have more training in applying psychological techniques appropriate for desensitizing anxiety. It may be favorable for math teachers to have more training in counseling and educational psychology so that they can recognize and help to reduce cases of math anxiety within their classrooms. The case studies revealed by all five students that feelings and anxieties about mathematics are never discussed in the mathematics classroom. It was reported that the overall mean on the SBI for the teachers was 43.07. This in itself may raise questions of whether the teachers in the sample actually have a high level of agreement about using the NCTM Standards. One would hope that a math teacher would be more familiar with the Standards, this study indicated this sample of math teachers scored at the 67th percentile in agreement with the Standards according to the SBI. The possible range of scoring on the SBI is from 16 to 64. The mean of 43.07 from the sample of teachers may suggest that overall, the teachers do not display high levels of knowledge or beliefs about using the Standards. This in itself may be important

to recognize. More preservice and inservice training for math teachers about the Standards may be necessary.

The aspects of students' level of math anxiety due to gender, grade level, or their teachers' beliefs about the Standards revealed some interesting. Hypothesis 2 was analyzed using a three-way ANOVA procedure to look for an interaction between the MARS mean score and gender, grade level, and teachers' beliefs. The only significant finding was between eighth-grade females and eighth-grade males. Research by Reilly (1992) and Bernstein (1992) supports this finding that females do not have higher levels of math anxiety until the late junior high/early high school period. Research by Tobias (1993) shows that the gap in mathematics and science is closing between the sexes.

The third hypothesis was tested using an ANOVA. The aspects of the study related to teachers' beliefs about the Standards and the years they have been teaching showed little evidence that teachers who have been teaching for less than five years agree with using the NCTM Standards according to the SBI more than teachers with five or more years of teaching experience. It is, however, noteworthy to mention that the teachers with fewer years of experience, who for the most part are recent college graduates, had mean scores on the SBI higher than teachers with more than four years of experience. This may be attributed to the

dissemination of the Standards during preservice training. Also, the Standards document is a fairly new text providing guidelines for math teachers and in fact, some teachers noted in their surveys that they were unfamiliar with the them. Julie mentioned in several of the interviews that she had a long-term substitute teacher for math. She mentioned that this teacher was a recent graduate and made learning math more enjoyable by doing innovative things in her math class. She had mentioned how the substitute teacher would use a great deal of cooperative group work and hands-on activities in class. She really liked this. She mentioned during the last interview that her previous teacher had returned and that they never did anything in groups or really interesting activities anymore. As suggested by the Standards, teachers should emphasize hands-on manipulatives, group work, math games, daily-life applications, and computer and calculator usage. A time to share feelings and frustrations about math and ways of coping and reducing such anxiety is suggested by this study.

Several other statistical applications were computed as mentioned previously. Interestingly, there were statistically significant differences in a Pearson Correlation between the total MARS mean score of the students and each of its subscale mean scores. It was found that students rated themselves as having more test anxiety

than number anxiety or math course anxiety. This supports findings from Anton and Klisch (1995) and Reyes (1984) who have shown close links between test anxiety and math anxiety. One fourth grade student in a local city school here in the Southeast wrote the following about testing:

> *The teacher pases [sic] out the paper thats [sic] when the butterflys [sic] began! Your heart is in your throt [sic]! You want to get all the math promloms [sic]. But there is no time to think! There is a blur of proloms [sic] to be done. Your head gets dizzy rushing you try to finish. No time to check over. It will have to do. I don't think I ever got all the prolmems [sic] in a timed test right. You get so nerus [sic] that you can't think, your palms swet [sic]. That feeling in your stomick [sic] is too [sic] bad for words. The dreaded time test.*

In the case studies each student's biography depicts his/her unique experiences with mathematics. While some students displayed very little math anxiety through discussions, others displayed more obvious signs of math anxiety. Interestingly enough, Brian and Juakila displayed the highest degrees of math anxiety out of the five participants. Like Brian, Juakila admitted that she didn't do her homework all the time. Both students scored low on the Attitude Inventory (Charles, Lester, and O'Daffer, 1987) on math problem solving. All five students, but mainly Brian, shared their dislike for long division. They all

said at various times that around fourth grade, math was not their favorite subject because of the many long division problems with such large numbers used in the problems and many assigned. Math teachers should not emphasize timed tests, allow only one right way to solve a problem, lecture, use of only the textbook, drill and practice, and large numbers of the same types of problems. The data collected from the five students in the case studies and the demographic information collected from all 772 students was consistent with what the NCTM Standards advocates in the teaching of mathematics.

All students commented on how they preferred their teachers to teach mathematics. All of the students mentioned how math games, projects, and group work were all ways which they felt were effective approaches to learning math best. Jill and Brian both mentioned how important it was for teachers not to embarrass students if they do not know an answer or if they do not feel comfortable about coming to the chalkboard. Based on these findings, in order to reduce student math anxiety, teachers should avoid any comments that have the potential to make subjects feel embarrassed or inadequate in their ability to do math. Another interesting thing to note is the idea of valuing mathematics. Each of the five students felt that math was a

very important subject and that they use it all the time in daily life experiences. Jill said that you need math "in the grocery store, for your education, jobs, and career." Jose said we need math to "help us with our bills, for life." Each of the students, no matter what their level of math anxiety, felt that it was extremely important to be learning mathematics.

Implications

Middle school mathematics teachers' beliefs about the use of the NCTM Standards and the level of students' math anxiety among their students was the focus of this study. Guidance for math educators and math anxious students drawn from this study are as follows:

1. The study showed no correlation between teachers' beliefs about the Standards and their students' level of math anxiety according to the Abbreviated Version of the MARS and the SBI. Based on findings from Hembree (1990), the only way math teachers can reduce students' level of mathematics anxiety is by implementing systematic desensitization. Therefore, mathematics teacher need to teach anxiety-filled students techniques such as the use of positive affirmation, visualization, proper breathing, and coping skills. They should also provide time in class for students to share and discuss their feelings about

mathematics in a non-threatening environment. It may be favorable for math teachers to take more course work in educational psychology and counseling to aid in treating students' math anxiety. The NCTM Standards alone may not reduce math anxiety, but strategies encouraged by the Standards may help to prevent math anxiety.

2. It has been shown by research that much of math anxiety is due to test anxiety; therefore, varied forms of assessment in the mathematics classroom perhaps may be the only way in which educators can diminish the pressures students face by taking math tests. NCTM (1989, 1991, and 1995) make recommendations for varied forms of mathematics assessment. Teachers can alleviate a great deal of student stress and anxiety by being eclectic in their approach to math assessment. This can be accomplished by implementing more team testing, projects, authentic demonstration, observations, portfolio assessments, and journal writing along with more traditional approaches. Research presented in Chapter II suggest that in order to prevent math anxiety, teachers need to place less of an emphasis on timed and paper and pencil tests. Testing in mathematics is often different from testing in other subjects where one might need to report back facts and declarative knowledge on a test. However, in mathematics there may be a certain procedural knowledge and uniqueness to each problem on a

mathematics test which makes preparation difficult.

3. This study showed evidence that there still exist difference between males and females and their levels of math anxiety in today's schools. Teachers need to encourage both males and females to pursue careers in mathematics. Teachers also need to be aware of the hidden curriculum that exists in the classroom that may effect how males and females feel about mathematics. Social norms may play a role in how males and females are perceived to behave and react to learning mathematics. In the case studies Juakila showed enthusiasm for mathematics, however, she had low math anxiety and felt the she would take the Tech-math track when she goes to high school. Teachers need to help students like Juakila to overcome her math anxieties and pursue a career in an area that she is excited about. Jill made an interesting comment about how the friends that she hangs around with all do well mathematically and are positive about the subject. Peers who like math may have a favorable impact on whether one likes math and has less anxiety about math.

4. This study has shown that the mean of 43.07 from the sample of teachers on the Standards' Beliefs Instrument may suggest that overall, the teachers do not display high levels of knowledge or beliefs about using the Standards. This in itself may be important to recognize. More

preservice and inservice training for math teachers about the Standards may be necessary. Jill, Jose, and Juakila all talked about how their teachers implemented various instructional strategies from the Standards such as math games, manipulatives, cooperative learning, and problem solving. Brian and Julie, however, often found their math classes boring with lecture, embarrassment, and being told to solve their math problems the same way the teacher tells them to or it will be counted wrong. This does not reflect the philosophy of the NCTM Standards.

Summary

Although math anxiety remains a perplexing, persistent, and only partially understood problem from which many people suffer, NCTM (1991, p. 6) says, "Classrooms should be mathematics communities that thrive on conjecturing, inventing, and problem solving, and that build mathematical confidence." Williams (1988, p.101) sums up a humane strategy that educators can use to alleviate math anxiety:

> To paraphrase a Chinese proverb: Tell me mathematics, and I will forget; show me mathematics, and I may remember; involve me... and I will understand mathematics. If I understand mathematics, I will be less likely to have math anxiety. And if I become a teacher of mathematics, I can thus begin a cycle that will produce less math-

anxious students for generations to come.

Nirenberg and Ruedy (1990) emphasize the importance of teachers incorporating in their math instruction confidence-building techniques. Also, it may be favorable to the students if less of an emphasis be placed on test taking, and competition: passing or failing and winning or losing. Ruedy and Nirenberg (1990, p.61) recount a poem by the Chinese sage, Chuang Tzu, from thousands of years ago:

The Need to Win

When an archer is shooting for nothing
He has all his skill.
If he shoots for a brass buckle
He is already nervous.
If he shoots for a prize of gold
He goes blind
Or sees two targets-
He goes out of his mind!
His skill has not changed. But the prize
Divides him. He cares.
He thinks more of winning
Than of shooting-
And the need to win
Drains him of power.

This study and others like it provided valuable insight into the critical role teachers play in assuring student success in mathematics by teaching more than the basics of the subject of mathematics. Research in this study may suggest that teachers can play an active role in both helping to prevent and in reducing mathematics anxiety in their students as well as perpetuating gender equity in the

learning of mathematics for all students. Studies have shown that the NCTM Standards can play a crucial role in preventing math anxiety. This and other research has shown that there still exists levels of math anxiety differences between the genders, and teachers must take this into account in order to provide equity in the learning of mathematics. Also, with the use of varied forms of assessment teachers may aid in preventing students from having such high levels of test anxiety and math anxiety. Teachers use of systematic desensitization techniques in the classroom can help to reduce levels of mathematics anxiety within all of their students.

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Appendix A

Standards' Belief Instrument and the

The *Standards'* Beliefs Instrument

Thank you for filling out this instrument for me!

Directions: Complete the following survey by answering each question. Please do not include your name.

A. Demographic Information

1. The number of years you have been teaching:
   4 or less 5 - 10 11 - 20 more than 20

2. The number of years you have been teaching math:
   4 or less 5 - 10 11 - 20 more than 20

3. Your highest educational level:
   Bachelor's Master's Beyond Master's Doctorate

4. What math grade level have you taught at the longest?
   Elementary 6 - 8 9 - 10 11-12 or higher

5. What teaching credentials do you hold for teaching math? (mark all that apply)
   Elem. math Middle math Secondary Other

6. College Undergraduate major:
   Math Ed. Math Liberal Arts Other

7. Your age range:
   24 or younger 25 - 35 36 - 45 46 or older

8. Familiarity with the NCTM *Standards:*
   None Little Some A great Deal

9. Number of classes you teach of math a day:
   3 or less 4 5 6 or more

10. What would you estimate is the current rate of your students' math anxiety:
    none Little Some A great deal

11. Do you think students these days have more math anxiety then they did in the past?
    yes no The same

12. Your Gender: Male Female

B. *Standards'* Beliefs Instrument

Directions: Shade in the answers that best describe your feeling about the following statements on the scantron grid provided. Use the following code:

1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree.

13. Problem solving should be a SEPARATE, DISTINCT part of the mathematics curriculum.
1 2 3 4

14. Students should share their problem-solving thinking and approaches WITH OTHER STUDENTS.
1 2 3 4

15. Mathematics can be thought of as a language that must be MEANINGFUL if students are to communicate and apply mathematics productively.
1 2 3 4

16. A major goal of mathematics instruction is to help children develop the beliefs that THEY HAVE THE POWER to control their own success in mathematics.
1 2 3 4

17. Children should be encouraged to justify their solutions, thinking, and conjectures in a SINGLE way.
1 2 3 4

18. The study of mathematics should include opportunities of using mathematics in OTHER CURRICULUM AREAS.
1 2 3 4

19. The mathematics curriculum consists of several discrete strains such as computation, geometry, and measurement which can be best taught in ISOLATION.
1 2 3 4

20. In K-4 mathematics, INCREASED emphasis should be given to reading and writing numbers SYMBOLICALLY.
1 2 3 4

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21. In K-4 mathematics, INCREASED emphasis should be given to use of CLUE WORDS (key words) to determine which operations to use in problem solving.

1 2 3 4

22. In K-4 mathematics, skill in computation should PRECEDE word problems.

1 2 3 4

23. Learning mathematics is a process in which students ABSORB INFORMATION, storing it easily retrievable fragments as a result of repeated practice and reinforcement.

1 2 3 4

24. Mathematics SHOULD be thought of as a COLLECTION of concepts, skills algorithms.

1 2 3 4

25. A demonstration of good reasoning should be regarded EVEN MORE THAN students' ability to find correct answers.

1 2 3 4

26. Appropriate calculators should be available to ALL STUDENTS at ALL TIMES.

1 2 3 4

27. Learning mathematics must be an ACTIVE PROCESS.

1 2 3 4

28. Children ENTER KINDERGARTEN with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.

1 2 3 4

Appendix B

Abbreviated Version of the Mathematics Anxiety Rating Scale

Abbreviated Version of the Mathematics Anxiety Rating Scale

Please do not write your name on this survey.

Directions: Circle the information for each question based on your experiences. Use the scantron sheet provided.

A. Demographic Information

1	Your age: 11	12	13	14	15 or Older
2.	Grade you are in:	7th	8th		
3.	Your Gender:	Male	Female		
4.	How much do you like math?				
	None	Not much	Neutral	Some	A great deal
5.	My two(2) favorite subjects are:				
	English	Soc. St.	For. Lang.	Science	Mathematics
6.	My two(2) least favorite subjects are:				
	English	Soc. St.	For. Lang.	Science	Mathematics
7.	What two (2) things do you like your math teacher to do?				
	Lecture	Hands-on Activities	Group Activities	Use Computers and Calculators	Quiet seat work

B. Mathematics Anxiety Rating Scale Instrument

Decide on the level of anxiety (anxiety means nervousness,worry, or panic) related to the following statements and bubble in your responses using the following codes: 1 = not at all, 2= a little, 3 = a fair amount, 4 = much, and 5 = very much.

Test

8.	Studying for a math test				
	1	2	3	4	5
9.	Taking a math section of an exam				
	1	2	3	4	5

10.Taking an exam(quiz) in a math course
1 2 3 4 5

11.Taking an exam(final) in a math course
1 2 3 4 5

12.Picking up a math textbook to begin working on a homework assignment
1 2 3 4 5

13.Being given homework assignments of many difficult problems that are due the next class meeting
1 2 3 4 5

14.Thinking about an upcoming math test 1 week before
1 2 3 4 5

15.Thinking about an upcoming math test 1 day before
1 2 3 4 5

16.Thinking about an upcoming math test 1 hour before
1 2 3 4 5

17.Realizing you have to take a certain number of math classes to fulfill requirements
1 2 3 4 5

18.Picking up math textbook to begin a difficult reading assignment
1 2 3 4 5

19.Receive your final math grade for a course
1 2 3 4 5

20.Opening a math book and seeing a page full of problems
1 2 3 4 5

21.Getting ready to study for a math test
1 2 3 4 5

22. Being given a "pop" quiz in a math class

1 2 3 4 5

Numbers

23. Reading a cash register receipt after your purchase

1 2 3 4 5

24. Being given a set of numerical problems involving addition to solve on paper

1 2 3 4 5

25. Being given a set of subtraction problems to solve

1 2 3 4 5

26. Being given a set of multiplication problems to solve

1 2 3 4 5

27. Being given a set of division problems to solve

1 2 3 4 5

Course

28. Buying a math textbook

1 2 3 4 5

29. Watching a teacher work on an algebraic equation on the blackboard

1 2 3 4 5

30. Signing up for a math course

1 2 3 4 5

31. Listening to another student explain a math formula

1 2 3 4 5

32. Walking into a math class

1 2 3 4 5